

# The Next Generation of Compression JPEG 2000

Bernie Brower

NSES – Kodak

bernard.brower@kodak.com

+1 585 253 5293

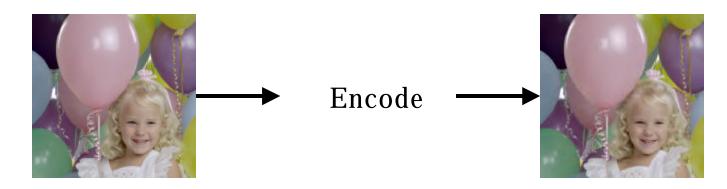


#### What makes JPEG 2000 Special

- With advances in compression science combined with advances in computers (speed and memory cost) JPEG 2000 has allowed a new compression paradigm to be born
- Advances in compression science
  - Wavelet transform
  - Bit plane arithmetic encoding
  - Embedded bit stream
- Advances in computers
  - Speed of CPU is fast enough to do more computation to achieve the same compression (more complicated compression algorithms)
  - Reduced cost of memory allows to take advantage of greater correlation lengths in an image
- A new paradigm is born
  - Meets the requirements of the client/server environment



# Old Compression Paradigm

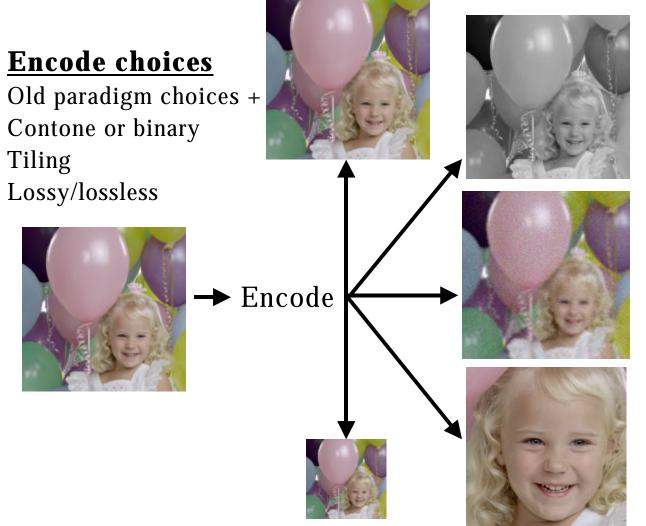


# Encoder choices color space quantization entropy coder pre-processing

# No decoder choices only one image post-processing



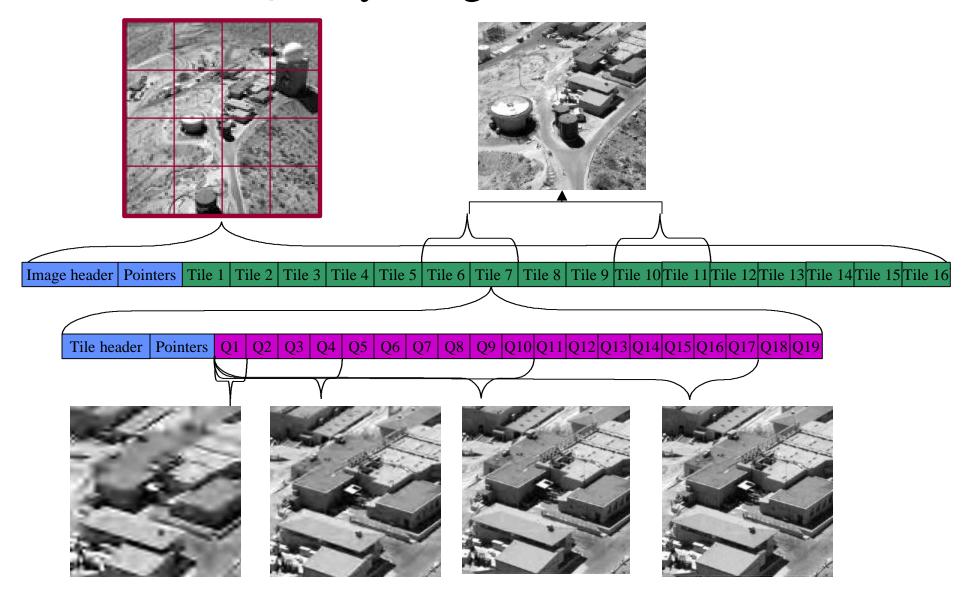
# New Compression Paradigm



#### **Decode choices**

Image resolution
SNR fidelity
Visual fidelity
Target filesize
Component selection
Lossless/lossy
Region-of-interest







#### Example of Progression by Accuracy



Original image was 8-bit uncompressed. All images extracted from a single 2.0 bpp compressed file.

With an embedded, progressively encoded bit stream, simply compress to high quality once and then decode the portion of the bit stream that meets your bandwidth requirements.



#### Example of Progression by Accuracy



Original image was 8-bit uncompressed. All images extracted from a single 2.0 bpp compressed file.

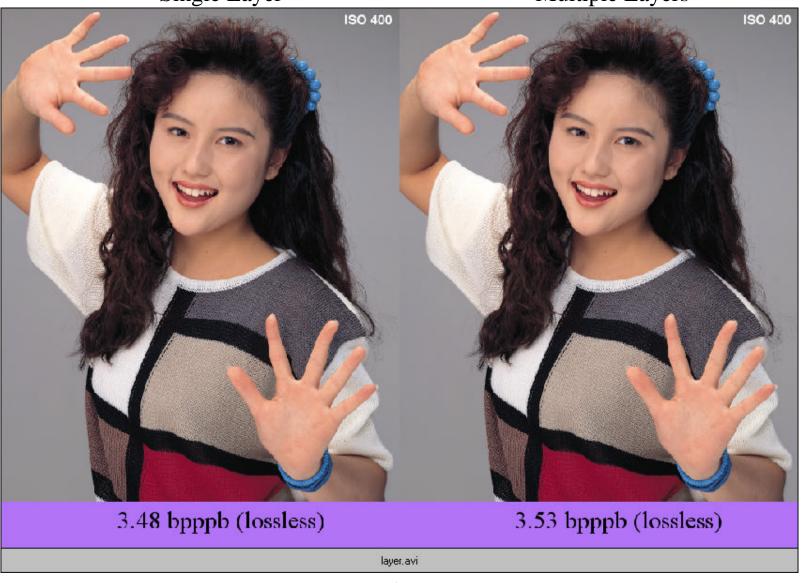
With an embedded, progressively encoded bit stream, simply compress to high quality once and then decode the portion of the bit stream that meets your bandwidth requirements.

# Examples of Progression by Resolution



# Effects of Layering

Single Layers Multiple Layers

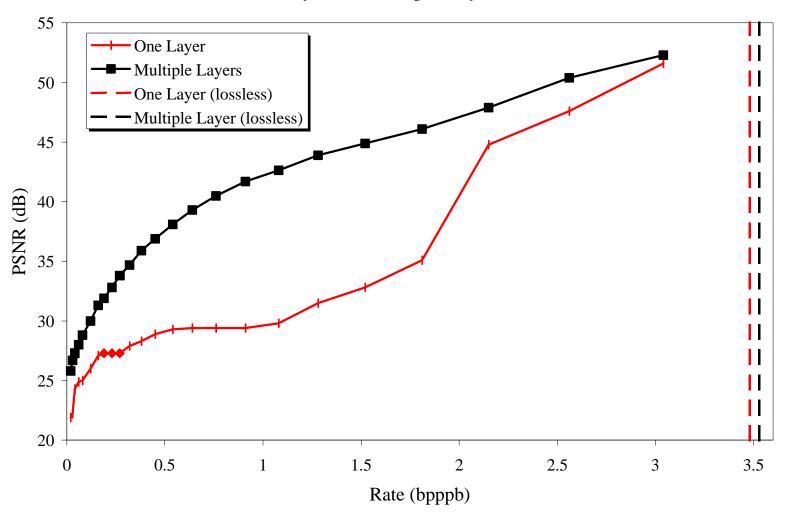


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## Effects of Layering

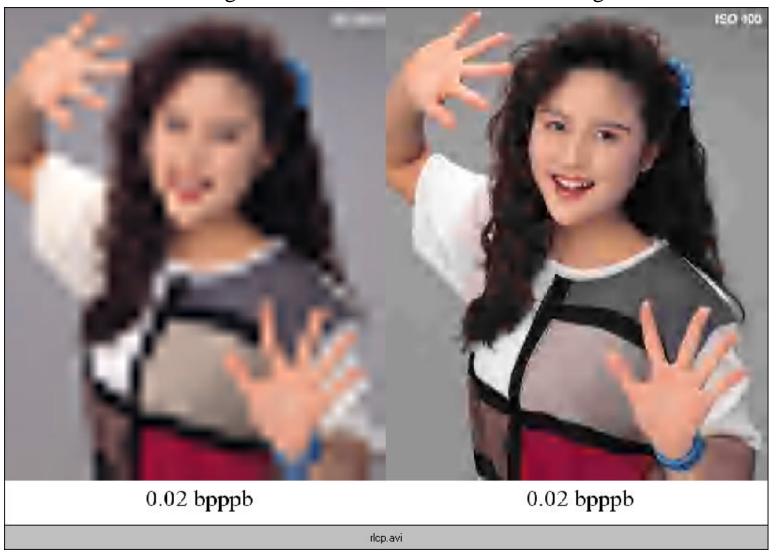
One Layer vs. Multiple Layers (LRCP)



# Effects of Progression

**RLCP Progression** 

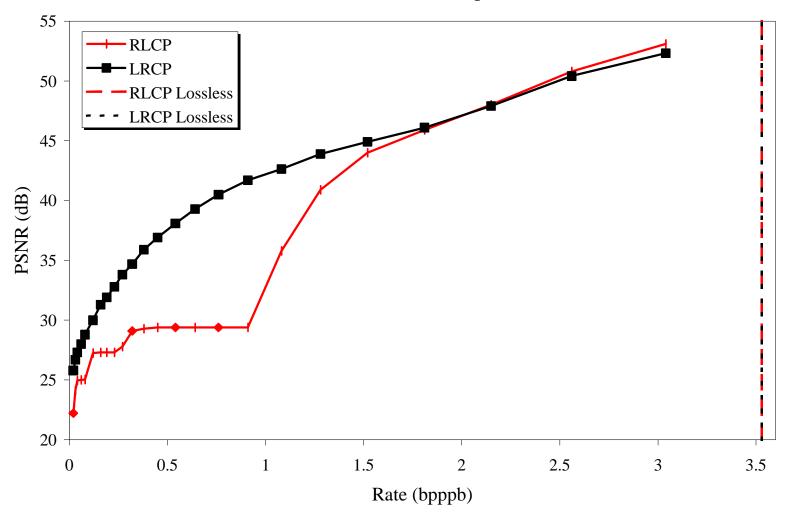
**LRCP Progression** 





# Effects of Progression

RLCP vs. LRCP Comparison





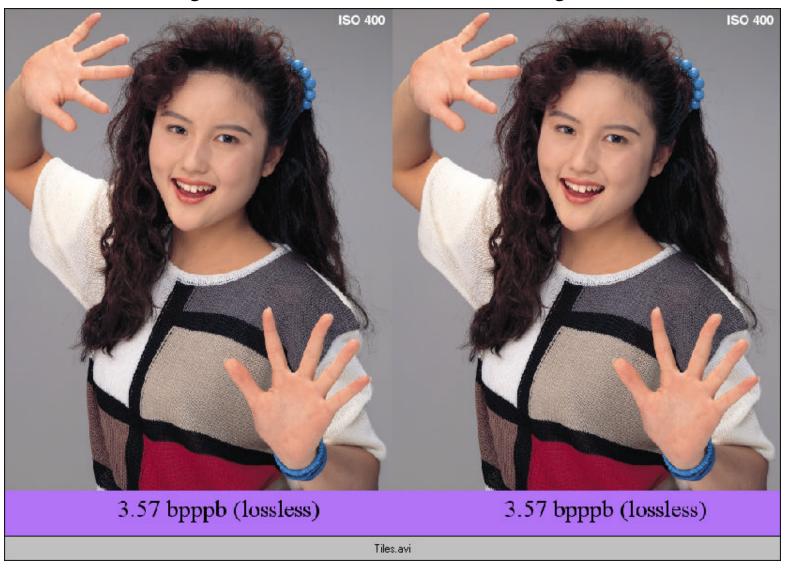
#### Tiles

- Tiles are independently coded sub images. Nothing crosses tile boundaries
  - Wavelet
  - Entropy coding
  - Layers
  - Progressions
- Tiles may be broken into tile parts. Tile parts from different tiles can be interspersed in a codestream
  - Only mechanism available to achieve "tile progression"
- In general, need to parse data out of tiles to achieve a different image quality
  - If all tiles are compressed at 2.0 bpp and you want 1.0 bpp, then need to go into each tile and get the 1.0 bpp

## Tiled Image Parsing

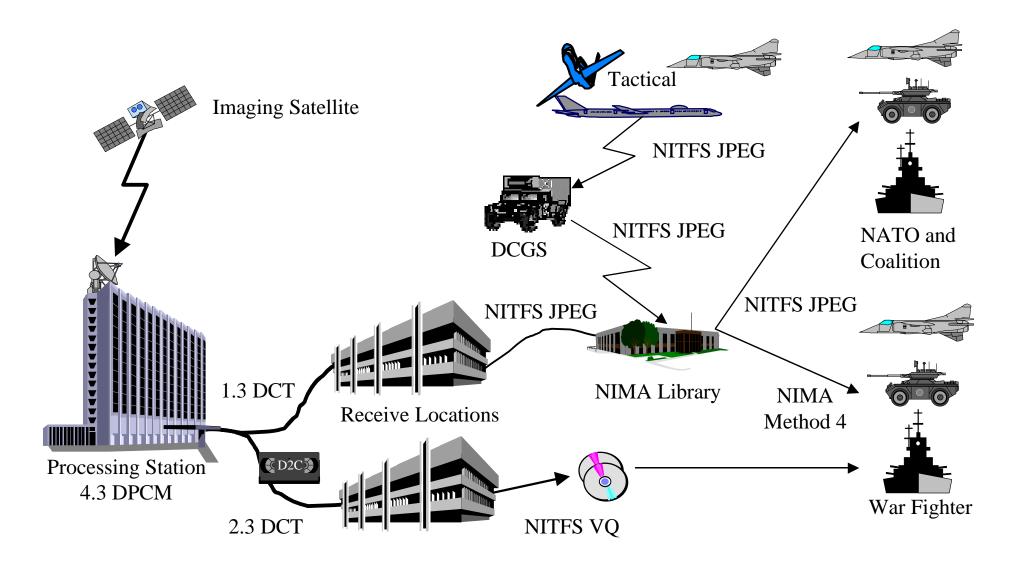
No Parsing Performed

Parsing Performed





#### National System for Geospatial Intelligence (NSGI)





#### J2K Solves Issues with Current Compression

- Current systems meet the component requirements
  - JPEG 2000 not only meets the current requirements but will increase throughput because of increased efficiency and increased functionality
- No efficient capability to handle MSI and HSI
  - JPEG 2000 can handle the compression of MSI and HSI data as well as take advantage of the spectral correlation if required
- Today most work is done in pixel (image) space
  - With JPEG 2000 you can parse compressed data to achieve different resolution, quality, and spatial locations (without decompression and recompression)
- Precision of imagery
  - JPEG 2000 allows for the precision of data from one bit (replacing the current bi-level) to 32 bit data



#### J2K Solves Issues with Current Compression

- Eight compression algorithms used within the NSGI architecture.
  - JPEG 2000 meets the requirements to replace seven of the eight 4.3
     DPCM, 2.3 DCT, 1.3 DCT, NITFS JPEG, JPEG lossless, NIMA method 4, and bi-level compression. (Does not meet VQ requirements)
- To achieve dissemination it is common to convert from one compression algorithm to another.
  - All systems in the NSGI (from national to tactical) only need to use one compression algorithm (increased interoperability), No conversion is needed.
- In order to achieve different compression ratios to support users, the compressed data must be decompressed and recompressed at the new desired compression ratio.
  - JPEG 2000 data can be parsed to achieve any lower bit rate than currently being used. There are several quality layers that are easily accessed



#### J2K Solves Issues with Current Compression

- Poor choice image quality impacts
  - Since concatenation is not required the choices will be reduced and preprogrammed into the JPEG 2000 Profile
- NITFS JPEG DCT image quality issues
  - Quality layers will be pre programmed which allows for less mistakes.
  - JPEG 2000 does not support tiling
  - JPEG 2000 allows from 1- to 32-bit imagery
  - JPEG 2000 defines color and multiple band data
- Only one resolution for all compression algorithms
  - JPEG 2000 uses multiple resolution data to achieve compression
  - Current profile defines 5 resolution levels (R0 R5)

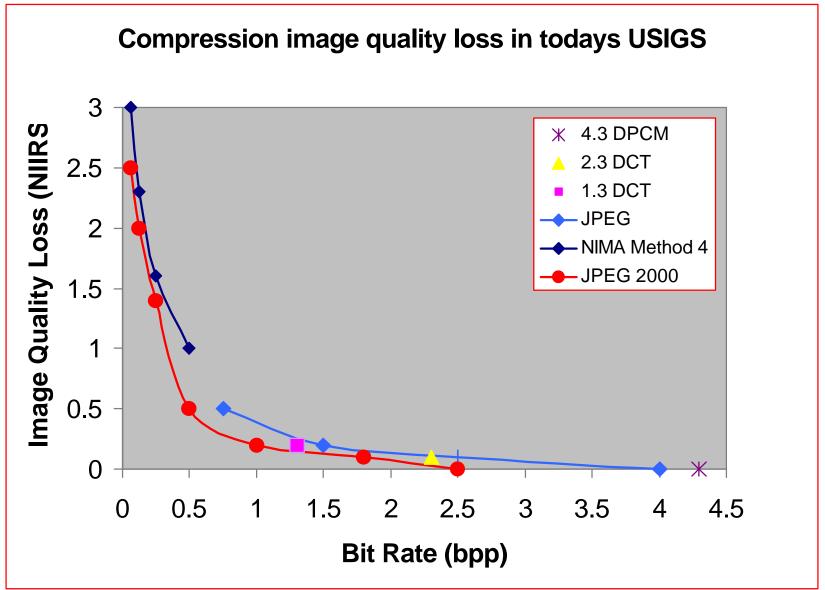


National System for Geospatial Intelligence (NSGI) **Tactical Imaging Satellite** -NITFS JPEG 2000 NITFS JPEG 2000 NATO and **DCGS** Coalition NITFS JPEG 2000 NITFS JPEG 2000 **JPEG 2000 JPEG 2000** NIMA Library **Receive Locations** D2C **Processing Station JPEG 2000** War Fighter NITFS VQ **JPEG 2000** 

Eight Compression algorithms used within the NSGI architecture

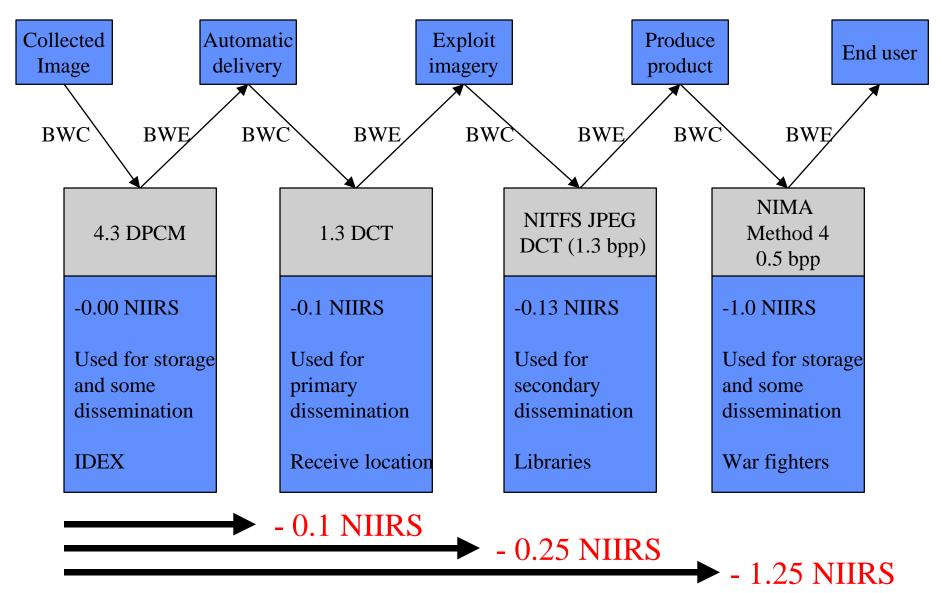


#### Meets or exceeds all current quality requirements





#### NSGI Concatenation Image Quality Hits





#### JPEG 2000 Dissemination of Imagery

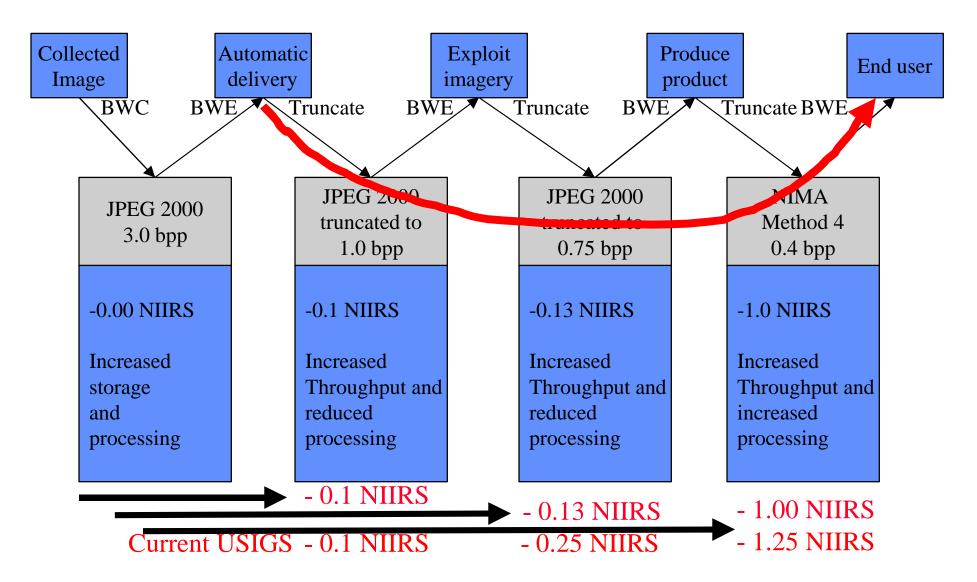




 Image header
 Pointers
 Tile 1
 Tile 2
 Tile 3
 Tile 4
 Tile 5
 Tile 6
 Tile 7
 Tile 8
 Tile 9
 Tile 10
 Tile 11
 Tile 12
 Tile 13
 Tile 14
 Tile 15
 Tile 16

Layers 1-3 for all tiles.





Image header Pointers Tile 1 Tile 2 Tile 3 Tile 4 Tile 5 Tile 6 Tile 7 Tile 8 Tile 9 Tile 10 Tile 11 Tile 12 Tile 13 Tile 14 Tile 15 Tile 16

Layers 1-10 for all tiles.







#### Resolution 3







#### Resolution 2







#### Resolution 1

